VOL. XXVIII AUGUST, 1912 No. 2

JOURNAL

OF THE

Elisha Mitchell Scientific Society

ISSUED QUARTERLY

CHAPEL HILL, N. C., U. S. A.

TO BE ENTERED AT THE POSTOFFICE AS SECOND-CLASS MATTER

Elisha Mitchell Scientific Society

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Journal of the Elisha Mitchell Scientific Society—Quarterly. Price $2.00 per year; single numbers 50 cents. Most numbers of former volumes can be supplied. Direct all correspondence to the Editors, at University of North Carolina, Chapel Hill, N. C.

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PROCEEDINGS OF THE ELEVENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE.

HELD AT THE UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL, N. C., FRIDAY AND SATURDAY, APRIL 26-27, 1912.

The Executive Committee met at 2.30 p. m., Friday, April 26, there being present Pres. H. V. Wilson and Sec'y E. W. Gudger *ex officio,* and Prof. A. H. Patterson, Dr. J. J. Wolfe, and Mr. F. Sherman, Jr. The Secretary reported that during 1911 ten members had withdrawn or been dropped for non-payment of dues, six new members had been added, and one old member reinstated on payment of back dues, making a total membership of 85 on Jan. 1, 1912. The Secretary also read his financial statement.

The following new members were then unanimously elected:

(1) E. E. Balcomb, professor of Agriculture, State Normal College.

(2) T. A. Bendrat, Instructor in Geology, University of North Carolina.

(3) W. H. Booker, Assistant Secretary State Board of Health.

(4) Dr. H. R. Fulton, Professor of Botany and Plant Pathology, Agricultural and Mechanical College.

(5) D. R. A. Hall, Associate Professor of Chemistry, University of North Carolina.

At 3 p. m. President Wilson Called the Academy to order and appointed the following committees:

Nominating — Collier Cobb, Z. P. Metcalf, and C. A. Shore.
Auditing — J. J. Wolfe, A. H. Patterson, and C. S. Brimley.
Resolutions — F. Sherman, Jr., E. W. Gudger, and W. A. Withers.

The reading of papers was then begun and continued until adjournment at 5:30 p. m., at which time eleven had been finished.

At 8 p. m. the Academy reassembled in Chemistry Hall and was cordially welcomed to Chapel Hill by President F. P. Venable, of the University of North Carolina. President Wilson, of the Academy, after responding to the address of welcome, then delivered the Presidential Address: "Zoology in America Before the Present Period." The hall then being darkened, Prof. A. H. Patterson gave a beautiful demonstration of luminous electric waves. Next, by special invitation, Dr. Thomas W. Pritchard gave his paper on "Wood Distillation." This being a new and important industry for our state was of much general interest to the members of the North Carolina Section of the American Chemical Society. At the same hour, Dr. W. S. Rankin, Secretary State Board of Health, delivered a lecture on "Hygiene and Sanitation" before the student body of the University, in Gerrard Hall.

The Academy then adjourned to attend the smoker given by the local members at the hospitable home of Dr. Isaac H. Manning, while the ladies in attendance were entertained at a reception by Mrs. Dr. Lawson.

The Academy reconvened at 9:10 a. m., Saturday morning, in annual business meeting. The minutes of the last meeting were read and approved.

The Nominating Committee reported for officers for 1912-13: President, Mr. C. S. Brimley, Naturalist, Raleigh; Vice-President, Prof. John F. Lanneau, Professor of Astronomy, Wake Forest College; Secretary-Treasurer, Dr. E. W. Gudger, Professor of Biology and Geology, State Normal College. Additional members of the Executive Committee: Prof. Julian Blanchard, Professor of Engineering, Trinity College, Durham; Mr. S. C. Clapp, Orchard and Nursery Inspector, State

Department of Agriculture, Raleigh; Dr. John A. Ferrell, Secretary for Hookworm, State Board of Health, Raleigh. The nominations were adopted unanimously.

The Auditing Committee reported the Treasurer's statement correct, and it was ordered printed in the minutes.

RECEIPTS

Balance last audit	$183.58
Dues paid 1912	99.00
Interest Savings Bank Deposit	5.39
Total	$287.97
Expenses	94.97
Balance	$193.00

EXPENDITURES

Printing	$ 5.50
Proceedings	75.00
Type Writing	2.35
Stamped Envelopes	12.12
	$ 94.97

RESOURCES

Savings Bank Balance	$138.68
Checking Bank Balance	54.32
Total	$193.00
Dues unpaid, 1912	25.00
Stamped Envelopes on hand	7.50
	$225.50
Less Outstanding Debts	82.00
Estimated Balance	$143.50

OUTSTANDING DEBTS

Proceedings, 1911-12	$ 75.00
Miscellaneous (about)	7.00
	$ 82.00

The Committee on Resolutions moved: That we hereby express our sincere thanks to the University for granting us the use of appropriate rooms for our meetings; to the Faculty and ladies for their kindly attentions; and to Dr. Isaac Manning for the pleasant smoker of last evening. And this was carried unanimously.

At the suggestion of Professor Edwards, and on motion of Professor Patterson, the President appointed a committee to work up and bring before the Academy, at its next annual meeting, a report on ventilation of school houses, churches, courthouses, theatres, and other public buildings in our state. After consideration by the Academy, it is hoped that we may be able to make recommendations to the State Legislature with regard to laws on ventilation. The committee consists of Prof. C. W. Edwards, Professor of Physics, Trinity College; Prof. A. H. Patterson, Professor of Physics, University of North Carolina; and Dr. C. A. Shore, Director State Laboratory of Hygiene.

At 9:30, by special arrangement between the Secretaries of the two bodies, there was held a joint meeting of the Academy and the North Carolina Section of the American Chemical Society, at which Dr. J. E. Mills gave his "Report on Molecular Attraction and Gravitation," and the chemical papers on the program of the Academy were read. The Chemists then adjourned to hold their stated meeting, and the reading of papers was continued in the Academy until adjournment for luncheon at 1:30, at which time twenty-five papers had been read. On reconvening after luncheon the consideration of papers was completed, and adjournment had at 3:20 p. m.

The following members were in attendance: Bendrat, T. A.; Blanchard, Julian; Booker, W. H.; Brimley, C. S.; Cain, William; Clapp, S. C.; Cobb, Collier; Daggett, P. H.; Edwards, C. W.; Ferrell, J. W.; Gudger, E. W.; Hall, R. A.; Herty, C. H.; Hutt, W. N.; Ives, J. D.; Lay, G. W.; Lockhart, L. B.; Metcalf, Z. P.; Metcalf, Mrs. Z. P.; Mills, J. E.; Patterson, A. H.; Rankin, W. S.; Sherman, Franklin, Jr; Shore, C. A.; Tillman, Miss O. I.; Venable, F. P.; Wheeler,

A. S.; Wilson, G. W.; Wilson, H. V.; Withers, W. A.; Wolfe, J. J.—31 out of a total membership of 90.

In addition to the Presidential Address, and the demonstration of electric waves, the papers on the Academy's program numbered twenty-nine. Of these four were read by title, one was reported on by President Wilson in the absence of the member, and the others were all read in order as shown on the program. Two things characterized the meeting: First, the number of papers dealing with hygiene, sanitation, and public health; and second, the discussions which followed the presentation of nearly every paper on the program.

In addition to the Presidential Address and the demonstration of electric waves, the following papers were presented:

Notes on the Distribution of the More Common Bivalves of Beaufort, N. C., Henry D. Aller.
[Published in full in this issue.]

The Relation of Vital Statistics to Public Health Work, Warren H. Booker.

Further Notes on the Yellow Fever Mosquito at Raleigh, C. S. Brimley.

Although this species was common in my vicinity in 1910, it was ten times more abundant last year (1911).

In the early part of the season it appeared to be mostly confined to the southern half of the city, and mainly to the eastern half of that; later on, it spread practically all over Raleigh, having reached the city limits on Hillsboro street in the west, and nearly as far on Glenwood avenue in the northwest. At both these places, however, it only occurred in small numbers. Over the major portion, however, of Raleigh it was very abundant and annoying from August to October inclusive, while at my house it was noted from late July to mid-November.

Unlike other mosquitoes, it bites in the daytime, even during the period of brightest sunshine, and appeared to show a decided inclination to bite people on the ankles, so that the wearers of

low-cut shoes suffered more than other people. Only the females were observed to bite, but the males were also noted to come around a sleeping child when protected with mosquito netting, and to perch on the netting as if they also wished to bite. None of this sex, however, was found with the bodies distended with blood. The sexes were present in about equal numbers.

Occasional specimens of this species have been taken in the past, and in 1910 they were common, increasing vastly in numbers in 1911. Now, what was the cause of this? I surmise that the series of mild winters preceding 1911 was one cause why this southern species got such a foothold. Another reason, I believe, was that owing to the drought, the rain-water barrels used by negroes stayed undisturbed for several weeks with just enough water in them to keep them from falling apart, and as, of course, no water was drawn from them and none ran in, the mosquitoes had an excellent opportunity to breed undisturbed, and it takes a very little water to supply breeding places for thousands of these little pests.

Some Records of Incipient Fern Growth in Carboniferous Time, Collier Cobb.

Race Preservation, Geo. W. Lay.

Notes on the Larvae of the Marbled Salamander, E. W. Gudger.

Larvae 1½ to 2½ inches long, with external gills, have been taken in brooks in the college park for several years past. This spring some thirty or forty were taken in a muddy pool in the same park. When caught these were nearly colorless, but when exposed to the light in aquaria set before windows in the laboratory they very quickly became pigmented. These were first thought to be the young of the common salamander, which had retained their gills over winter, but discussion of the paper elicited the interesting information from Mr. C. S. Brimley that the Marbled Salamander lays its eggs in the fall, these are hatched and the larvae retain their gills over winter, losing them in the late spring. Some kept by the writer for a month now show only stumps of these structures.

The Seedling of the Live Oak, W. C. Coker.
[Published in full in this Journal for May, 1912.]

Notes on Mutation, W. N. Hutt.

The Effect of Temperature on the Contact Resistance of Carbon, P. H. Daggett.

The Gloomy Scale, an Important Enemy of Shade Maples in North Carolina, Z. P. Metcalf.
[Published in full in this issue.]

The Dispensary as a Factor in the Prevention and Cure of Hookworm Disease, John W. Ferrell.
[Published in full in this issue.]

Two Parasitic Hymenomycetes, Guy West Wilson.

Attention is called to the attacks on apples in the Piedmont section of the state by *Septobasidium pedicellatum* (Schw.) Pat. which also occurs over a considerable area of the Southern states on various hosts. *Fomes roseus* (Albert & Schw.) Cooke, is also noted as causing a disease of the red cedar, locally very destructive in Eastern North Carolina.

The Toxicity of Cotton Seed Meal, W. A. Withers and B. J. Ray, with the co-operation of R. S. Curtis and G. A. Roberts.

The Walden Inversion, Alvin S. Wheeler.

Note on the Fundamental Basis of Dynamics, William Cain.
[Published in full in this issue.]

Discovery of some new petroglyphs Near Caicara on the Orinoco, T. A. Bendrat.

In the winter of 1908 and '09, while surveying the region about Caicara, Venezuela, the writer discovered some new petroglyphs which belong, geographically and genetically, to the

same large group of stone-carvings found scattered over a wide area which is bounded by the Orinoco, the Atabapo, the Rio Negro, and the Cassiquiare. While Alexander von Humboldt mentions only two petroglyphs from the region of Caicara, "el sol" and "la luna," of which the writer saw only "el sol," neither he nor any other traveler who ever touched that point seem to have known any of the stone-carvings found by the writer. These newly discovered petroglyphs occur on the banks of the Orinoco and in the adjacent forest. They may be divided up into three distinct groups, one representing the simplest type and consisting of almost geometrical circles, one in the other, the center of the most inner one being hollowed out; another group of a more complicated type and of more fantastic design, of which only one figure was found; and a third group that evedently represents the highest type in the development of this art of petroglyphy and that comprises "el sol," that was already known to Humboldt, and the new petroglyph that was discovered by the writer, namely "el tigre." All these petroglyphs are supposed to have been produced in prehistoric times. As to their meaning there exists quite a number of theories. The writer holds the view, on the base of extended studies in fetichism, that they represent records of earlier and later fetichism, while they have served, at the same time, as an indirect means to develop the art of sculpture that grew out of the art of petroglyphy.

The Work of the State Laboratory of Hygiene, C. A. Shore.

Some Reduction Phenomena in Hydroids, H. V. Wilson.

Some New Questions Concerning Ventilation, C. W. Edwards.

Solution of the Draftsman's Difficulty, John F. Lanneau.

George Marcgrave, the First Student of American Natural History, E. W. Gudger.

George Marcgrave was a member of the Dutch expedition to Brazil under Johann Moritz, Count of Nassau-Siegen, during the first half of the seventeenth century. He assiduously

studied the animals and plants of Brazil during the years1638-1644. In 1648 his drawings and observations, under the title *Historiae Rerum Naturalium Brasiliae* were published jointly with the *De Mericina Brasiliensi* of William Piso under the general title *Historia Naturalais Brasiliae.* Marcgrave's part of this work covers 303 folio pages, in which he describes 301 plants, with 200 figures and 367 animals, of which 222 were figured. Of these 668 forms practically all were new to science and probably none of the 422 figured had ever been drawn before.

Marcgrave knew nothing of the classification of flowers based on stamens and pistils, or of fishes by the count of fin rays, but his descriptions are, for the times, remarkably clear and his drawings sufficiently exact for the plant or animal to be unmistakably recognized. No country in its early exploration has ever had such a great work published on its natural history.

A complete biography of Marcgrave is nearly finished and will shortly be offered for publication.

The Electrical Resistance of a Flowing Conductor, A. H. Patterson and V. L. Shrisler.

Capture of Raleigh, N. C., by the Wharf Rat, C. S. Brimley. [Published in full in this issue.]

The Water Molds of Chapel Hill, N. C., W. C. Coker.

Further Notes on the Geology of the Carolina Coast Line, Collier Cobb.

Transient Electrical Phenomena and their Relations to Modern Problems in Electrical Engineering, P. H. Daggett.

The Toxic Action of Haematin and Bile, W. H. Brown.

Notes on the Maturing of Bermuda Grass Seed, O. J. Tillman. [Published in full in this issue.]

Studies of Cotton Seed Meal Intoxication as to Pyrophosphoric Acid, W. A. Withers and B. J. Ray.

E. W. GUDGER, *Secretary.*

ZOOLOGY IN AMERICA BEFORE THE PRESENT PERIOD.*

By H. V. Wilson.

Zoology deals with the *phenomena* of animal life. A necessary and usually early step in the progress of this science in any quarter of the world is to discover and distinguish the kinds of animals — the species, as we say — there found. These in time become the objects of more and more intense and analytical study.

The earliest extant record of our fauna, as far as I know, consists of a series of water-color sketches made by John White, a member of the expedition which made the first settlement on Roanoke Island (1585), and governor of the second Roanoke Island colony. White's pictures, now preserved in the British Museum, show a number of our birds, fishes, insects, also plants and the appearance of the native inhabitants. Even before this, descriptions of some of our native forms, with specimens, had reached learned Europeans interested in science.

In the seventeenth century the French missionaries gave further information of this kind, included in the accounts of their travels. A few of the settlers, too, were sufficiently informed to deal with such matters. Thus John Winthrop, son of the first governor of Massachusetts, and himself governor of Connecticut, was a regular correspondent of the Royal Society. We owe an early record entitled "New England's Rarities" (1672) to an English traveller, John Josselyn, who mentions a good many of our vertebrates, some mollusks and crustacea, also some lower forms such as the star-fish and sea-nettle (jelly fish). Another Englishman, John Lawson, in his History of North Carolina (1714), mentions a number of our animals. His remarks concerning them are often interesting. Buffaloes, he says, he has known to be killed on the hilly part of the Cape Fear river. Beavers were numerous in North Carolina at that time, and whales were abundant off the coast. He lists under

*Presidential address before the North Carolina Academy of Science, April 26, 1912.

the insects (!) alligators, some lizards, several snakes and turtles. He mentions the bull-frog and remarks on the character of his voice. Lawson also mentions some invertebrates: crawfishes, "muscles," the stone crab, the common edible crab, clams, the conch, and the peculiar egg cases of the latter.

Much the most comprehensive and valuable of the early accounts of our fauna is to be found in Mark Catesby's Natural History of Carolina, Florida, and the Bahama Islands. This great work was republished twice. The first volume of the first edition came out in 1732. Catesby, an Englishman, spent several years in this country, and in his beautiful folio plates we find faithful pictures of many of our present wild neighbors.

The eighteenth century, which saw Franklin's remarkable inquiries into the nature of electricity, brought out a few contributions to zoology from native Americans. John Bartram, more specially known as a botanist, should not be forgotten. Bartram, who was a Quaker farmer in Pennsylvania, made good observations on our plants, animals, and fossils. These are described in a long series of letters (1734-1810) and in a journal. Most of Bartram's letters and his journal were sent to Peter Collinson, an English naturalist, who communicated selections to the Royal Society. Bartram was made King's Botanist in 1765 with an annual salary of fifty pounds. It is worthy of note that he was using a microscope in his study of plants in 1754. John Bartram's son, William Bartram, was a well known naturalist in his time. He published a volume of Travels in the Carolinas, Georgia, and Florida in 1791, and is said to have assisted Wilson in the production of his American Ornithology. At the close of the eighteenth century we also find natural history publications of some importance by B. S. Barton.

In the early years of the nineteenth century (1808-14) appeared an important work, important even today, on our birds: Wilson's Ornithology. Wilson was born and bred in Scotland. Another foreigner, Prince Charles Lucien Bonaparte, is the author of an Ornithology supplementary to Wilson's. This was published with some supervision from Americans, Say and

Godman, 1825-33, in this country. One of the earliest technical papers of any considerable importance by a native American is Thomas Say's Crustacea of the United States (1817-18). The first comprehensive work on natural history by a native born American is Dr. Richard Harlan's *Fauna Americana,* bearing the date 1825. This was followed by a valuable work on insects, Thomas Say's American Entomology (1824-28), and by Dr. John D. Godman's three volumes on North American mammals, (1826-28). Barton, Harlan, and Say were natives of Philadelphia, and the two former taught in medical schools in that city. Say's father was a physician and apothecary. He himself was engaged in business, unsuccessfully, in Philadelphia, and later in one of the several attempts made to establish an ideal community — in this case, in New Harmony, Indiana. Godman was born in Annapolis, Maryland, and taught in several medical schools. These early naturalists have the personal interest attaching to pioneers, and it will be seen that in America, as elsewhere, zoology in its beginnings was frequently linked with the profession of medicine. The prominence of Philadelphia as an early zoological centre should be noted. The Academy of Natural Sciences of that city, which has since become so famous, was founded in 1812, Say joining the society in that year.

With the appearance of the works just mentioned, the study of natural history, viz., the description of species with accounts of habits and local distribution, was well under way. In 1827 Audubon began to publish his famous and beautifully illustrated volumes on the "Birds of America." Isaac Lea started a long series of contributions on the classification, anatomy, and embryology of fresh water mussels in 1829. Say's Shells of North America appeared in 1830, Conrad's American Marine Conchology in 1831. Nuttall's Manual of Ornithology of the United States and Canada came out in 1832-34. The four volumes of the first edition of Holbrook's North American Herpetology were published 1836-40. This work, a well known classic dealing with the amphibia and reptiles, and ranking with Audubon's Birds among the early achievements of Amer-

can science, had for its author a South Carolinian, John Edwards Holbrook, Professor of Anatomy in the Medical College of the State of South Carolina. Holbrook was an excellent naturalist, a man of eminence. We learn from his list of honors that he was a member of the Royal Medical Society of Edinburgh, of the Philadelphia Academy of Sciences, and of the Lyceums of Natural History in New York, Boston, and Baltimore. It is noteworthy that in Philadelphia, New York, and Boston the local lyceum or academy of that early time has become a strong institution, supporting and publishing investigations and serving as an instrumentality for the cultivation of the public.

In the decade of 1840-50 a number of works of importance appeared. Much the most imposing is De Kay's Zoology of New York in five large, well illustrated volumes. This widely used work contains descriptions of all the animals known at the time to occur within the state of New York, together with brief descriptions of those occasionally found near the border of the state. These volumes form a part of a general Natural History of New York descriptive of minerals, geological formations, soils, and of the plants and animals of the state. The publication was the outcome of the passage of a bill in 1836 calling for a complete geological survey of the state. For the purposes of this survey the sum of $130,000 was appropriated. The first volume of the report was published in 1842. It includes a description of the mammals, together with a long and historically interesting introduction which embodies a geographical and political history of the state, together with sketches of its colleges and schools, its press, its learned professions, laws, material improvements, etc. The introduction includes also (I quote) "an account of the studies and productions of our citizens in the departments of history, classical learning, mathematical science, pure and mixed biography, travels, romance and general literature, poetry and the fine arts; and of researches in our zoology, botany, meteorology, chemistry and mineralogy; with an account of the inception, progress, and consummation of the survey, to which those researches gave

birth." The result is a picture of a strong, ambitious state, moving rapidly along the path of progress. Wm. H. Seward is the author of the introduction and he remarks that "This review, although circumscribed and imperfect, furnishes gratifying proof that a republican government is not unfavorable to intellectual improvement." Seward, in speaking of the history of geology and geological surveys in this country, calls to mind (I quote) that "North Carolina has the honor of having been the first to send geologists into the field. Professor Olmstead's report upon the economic geology of that state was published in 1825." I may add that the work of our State Survey in making known the natural resources of North Carolina has kept step with the general progress of the state since Olmstead's time. It never was so efficient as under the direction of its present head, Dr. J. H. Pratt, and his immediate predecessor, Dr. J. A. Holmes. As a pleasing piece of testimony, I call to mind the beautiful volume on the Fishes of North Carolina, from the pen of Dr. H. M. Smith, published in recent years as a state document by the Survey. In leaving De Kay's Zoology, which reflects such credit on a great state, let me mention that New York at that time (U. S. Census 1840), contained only 2,428,-921 inhabitants.

Shortly after De Kay's work, appeared (1846-49) J. D. Dana's report on the Zoophytes of the Wilkes Exploring Expedition which the U. S. Government had sent out into the Pacific ocean, 1838-42. Dana's descriptions of these simple marine forms made a volume which took place along with the best European work of its sort. In the same decade appeared Gould's Invertebrata of Massachusetts (1841), Haldeman's Monograph of the Pond-snails of the U. S. (1841-44), Audubon and Bachman's Quadrupeds of America (three volumes, 1846-54), Storer's Synopsis of the Fishes of North America (1846).

Up to this date the work of zoologists in America had been almost completely restricted to the field of systematic zoology, viz., they had been engaged in the description and classification of species and, more incidentally, with habits and distribution. In 1846 came the already famous Swiss naturalist, Louis

Agassiz, to this country. He came primarily to deliver some lectures in Boston. Agassiz's personality captivated the country and, although he freely criticised it, the country evidently captivated him, for he remained here until his death in 1873, refusing offers, of the most attractive kind, of posts in European institutions. Agassiz himself was a systematic zoologist, a describer and classifier of high rank, but he was much more. He brought with him a practical familiarity with the problems and points of view of morphological zoology which had been engaging the attention of the great European naturalists for decades. His mind and methods were comparative, and he emphasized the importance of looking not so much at species, as at the fundamental points of structure in the anatomy of groups, the changes of form undergone during embryonic development, and the structure of extinct forms. Moreover, he laid stress on the importance of looking at these three sets of phenomena together. He maintained more definitely than any of his predecessors that the embryo passes through a series of changes during which it resembles successively the lower members of the great group or type to which it belongs; and that the fossils in any group as we proceed from the oldest to the more recent, show a similar progress from simplicity to complexity of structure. How like an argument for evolution all this sounds! But Louis Agassiz to the last held out against evolution, and refused to see that the parallelisms or fundamental similarities between the series of fossils, of existing forms, and of embryonic stages, were to be explained as the result of kinship. Following Cuvier he looked on the history of the world as divisible into a series of distinct epochs, each of which was inaugurated by a special act of creation. The several epochs with their living organisms were brought to a close by tremendous, supernaturally induced disasters styled cataclysms. Between the species of two epochs there could be, he maintained, no kinship, no material or genetic connection. Whatever resemblances existed between species were, to his mind, purely ideal and due to the fact that organisms represent the embodied thoughts of a superior power. This way of look-

ing at the living world seems strangely archaic, poetic, to us who have every reason to believe that all material phenomena are due to material causes, and that resemblances between natural species, living and fossil *are* material phenomena and of the same kind as resemblances between such races as have been produced from a common stock through man's selective breeding. Agassiz's interpretation of the parallelism between anatomical, paleontological, and embryological facts, obviously must be classed in that group of hypotheses which make immediate appeal to hyperphysical powers in order to explain natural phenomena.

But although today we can only look on Agassiz's theorizing as we look on poetry, we see beneath this cloudy mantle a great man and a master in science, one who exercised a strong and beneficial influence on American zoology and American science in general through his constant injunction to compare and so learn what is general, what is fundamental.

As new ideas come into a science, new fields of investigation are opened, but the old ones are not necessarily closed. And, as we very well know, the study of systematic zoology did not come to an end with the advent of the Agassiz period of comparison and transcendental interpretation, nor later with the advent of the evolution idea, nor later still with the oncome of the present era of analysis and experiment. On the contrary, along with the rise and development of the many comparative and experimental branches of modern zoology, the description and tabulation of the earth's fauna has gone steadily on, and is today progressing as actively as ever. It is pleasant to think that members of our own society are helping in this piece of the world's work. When we come to think how imperfect is our knowledge, even today after so much labor, as to the kinds of animals that live with us in garden and orchard, in wood and meadow, in pond and stream, and above all in the sea, naturalists realize what a vast deal of work stands before the describers and classifiers. Everywhere search reveals new forms. As to the place of these in classification how difficult it often is to decide. We know that species are not the immutable things Lin-

naeus had in mind. They are only groups of individuals subject to the transforming influence of many factors. Ideally the systematist when he lists his form should not only be able to pick out its characteristic points, but through comparison of many live individuals from different localities and through experiment he should know whether such characteristics are produced and maintained through the continuous action of food, climate, or other environmental influences; or whether they are ingrained in the constitution of the race, viz., hereditary, and so in some degree independent of the environment. Should the characteristics prove hereditary, the relation of the new form to other closely similar "kinds" should be determined, before the form in question is listed as species, subspecies, mutation, or what not. If the systematist should carry out this ambitious program for all the kinds of animals he encounters, his task would indeed be stupendous. For the most part he must be content with listing his kinds in such wise as to make it a known and accessible fact that a form of definite anatomical peculiarities occurs in such and such a region. This done, he has advanced science measurably, and may leave it to others, or to himself in another capacity, to select from the vast mass of species certain ones for intensive study of a comparative and experimental character.

Many of the ablest and most highly praised pieces of zoological work emanating from America have been memoirs in systematic zoology. But it should be added that such memoirs show us that great success in classification requires a wide and deep knowledge of the group to be handled. The classifier should, above all, be familiar with the comparative anatomy and embryology of the group, and with the periodic or other modifications of structure incidental to function, habit, or nature of the home. And this means that he must be familiar with his forms as *living* animals, and that the size of the group be not too large. As representative classics in American systematic zoology I may pick out for mention Audubon's Birds (1827-38), Holbrook's Herpetology (1836-40), Dana's Crustacea of the Wilkes Exploring Expedition (1852), Louis Agassiz's Memoirs

on jelly fish and hydroids (1860-62), Leidy's Monograph on the amoeboid protozoa or Rhizopods (1870), Alexander Agassiz's Revision of the sea-urchins (1872), and the three reports by A. Agassiz, Lyman, and Brooks (1882-86), on the sea-urchins, ophiuroids, and stomatopod crustacea, collected by the British ship "Challenger" on her famous voyage of scientific exploration.

One of Louis Agassiz's strong predilections was for the study of embryology. The influence of his example and teaching in Cambridge and in Charleston, during his winter visits to that city, is apparent when we run through the list of American publications in zoology. Up to the time of Agassiz's arrival, practically no embryological investigations had been carried on in this country. But now we find during the period 1846-73 a very considerable number of investigations of this character going on, emanating from Agassiz himself, his associates, students, and ex-students. Agassiz studied the development of jelly fish, hydroids, and turtles. McCrady made important observations on the development of the jelly fish found in Charleston harbor. Alexander Agassiz, the son of Louis, a great naturalist who has but recently died, studied the development of ctenophores, starfishes, and annelid worms. Morse investigated the embryology of the brachiopods. Packard made known striking facts in the development of Limulus, the kingcrab or horse-shoe crab.

As it was with the study of embryology, so it was with the study of fossils. Agassiz's comparisons awakened interest and led to investigations. The most celebrated of these came from Leidy, Professor of Anatomy in the University of Pennsylvania, and dealt with the fossil vertebrates found imbedded beneath our western plains. These studies of Leidy were the precursors of a long series of discoveries made in later years, especially by Cope, Marsh, and Osborn, which have told us much about the ancient history of our western states.

When the study of embryology and the simpler animals became occupations of intellectual interest in Europe, some of the great naturalists like Johannes Müller, Professor in Berlin, began to make pilgrimages to the sea shore to study, especially

with the microscope, the wonderful phenomena of marine life. Agassiz brought with him to this country the interest in the sea and its organisms. This he spread, and in the last years of his life brought to a focus in the establishment of his famous summer school on the island of Penikese, the first of the marine laboratories now to be found scattered along our Atlantic and Pacific coasts. The Penikese laboratory exerted an immense influence, but served its purpose and ceased to be, unlike that other magnificent institution founded by Agassiz and developed by his great son, the "Museum of Comparative Zoology at Harvard College."

In the midst of Agassiz's career in this country came the publication of Darwin's Origin of Species (1859), and the speedy adoption by the great bulk of the thinking world of the theory of evolution. The ferment of the evolution idea shook America as it did other countries. Similarities such as Agassiz had been interpreting in poetic, transcendental fashion, became matters of more practical concern. The past history of the living world was opened to investigation, and with all the enthusiasm of explorers, ardent spirits on many sides began with fresh energy to dig for fossils, to trace the changes of form undergone by the egg in its course of development, to look for transitional types filling up the gaps between groups, and to study in detail the tissues and organs and plan of body of all animals, low and high, that could tell us anything of general interest about the kinship of groups. It takes an idea to make men work, and evolution was the new idea, more stimulating, more strengthening, as results came in, to the searcher than any of its predecessors. The ancestral history or phylogeny of each group was constructed and reconstructed, and reconstructed again, as new data became available. The data were in kind not different from the discoveries of fundamental similarities of structure, familiar to biologists in the pre-evolutionary epoch, but now they were discovered in places where the earlier naturalists had not looked for them, and even between the great groups or phyla sharp lines were wiped out. Above all the volume of discovery streaming in soon became far greater than

in previous epochs. This remarkably intense interest in the facts of structure, resulting in evolutionary interpretations in the shape of race-histories or phylogenies, was the most dominant force at work throughout the whole range of biology until about 1890. In zoology especially most of the strong, keen minds were active in such investigations.

Science consists primarily of demonstrable facts, arranged in generalizations of more and more comprehensive scope, in such wise as to expose the time relation between the antecedent facts or cause and the sequent facts or effect. These generalizations glued together with theory make up in any age the contemporaneous body of science, which the members of that generation see in the mind's eye when they piece together all they know or have some reason to believe in concerning material phenomena. Naturally as generalizations widen, and theories are verified, disproved, or changed, our mental picture of that stately building of science (to borrow a favorite Germanism) changes too. And so the picture drawn by those of a preceding generation may look in many particulars strangely unlike that which we see today, but if they *were* and we *are* good workers, the next generation will see in the two pictures beneath the superficial dissimilarities much the same basic framework of lines. It is this well known use of theory which exposes us sometimes to the dashing onset of the clever tongued and light minded, who allege that we are no better than others, that we too muddle up fact and fancy. Peace to the satirist and thanks, if only he have humor and not mere impudence! We do *not* muddle, or at any rate (for we are only men) we *try* not to muddle fact and fancy. Nevertheless we certainly eke out fact with fancy, in the shape of hypotheses. But these we must continually try out in the daily round of experience. Do observation and experiment confirm the fancy? we ask. And then we find, or others find, that most of the hypotheses prove untrue and are to be discarded. Some quickly prove true, and if for these we continue to use the term "theory," we do so from habit. So it is with the "cell theory," long ago demonstrated to be fact. Others deal with phenomena of such a kind that we can

not experimentally demonstrate or disprove the theory in its entirety. We then ask if any of the facts of observation and experiment contradict the theory, or do they corroborate it in that they prove explicable by it. And are there many such facts and of diverse kinds? In other words, have we worked with the theory a long time and found it to hold good? If so, after a time we practically cease to question it directly, and it comes into a use that is habitual and almost reflex. So it is with the theory of universal gravitation and so it is with the theory of organic evolution.

A gulf separates Agassiz's theory from that of evolution, and yet we must recognize that the actual investigations of the earlier school, the solid discovery of demonstrable facts and their formulation into generalizations, went on along much the same lines as in the later period. We may therefore with justice say that in America from about 1850 to 1890 it was the interest in fundamental form that dominated zoology. This was the great period of morphology to which zoology owes so much, and which began in Europe in the early years of the nineteenth century. Many of the most substantial results of biological inquiry have resulted from this intense comparative study of structure, adult and embryonic. That the body of all but the simplest animals, the protozoa, is composed of tissues, and these of microscopic units, the cells, each of which is comparable with a protozoan; that the egg from which a metazoan animal starts is but a single cell, and that this by division produces many cells which differentiate into the nerve, muscle, gland, and other tissues; that the cells early become arranged into two primary layers, which as such make up the body of low metazoa (coelenterates), but which in higher forms become infolded and outfolded so as to give rise to many internal organs: these are fundamental discoveries which, as Oscar Hertwig has said, are the answers to questions that baffled the most acute biologists and philosophers of earlier ages.

The bulk of the discoveries of morphologists are, of course, such as require for their comprehension some technical training. All I can say here is that this wealth of knowledge, so

comprehensive and detailed, forms an immense part of the safe, secure basis on which rest all the biological inquiries of today. As to the part that American zoologists have played in the development of morphology, while it cannot be claimed that they brought to light any of the very greatest generalizations, comparable with those of von Baer, Rathke, Haeckel, and Kowalevsky, the world owes to them a large number of acute and important investigations. In addition to the names I have already mentioned in speaking of the progress of embryology, two great Americans, who have recently died, should be referred to here, W. K. Brooks and C. O. Whitman.

It must not be supposed that the work in descriptive morphology is at an end. By no means! There is so much to be done that it will doubtless occupy many zoologists for centuries. But as was the case earlier with systematic zoology, so later with pure morphology: it no longer occupies the centre of the stage.

In dealing with evolution I have spoken as if the effort had been solely to reconstruct in the imagination the past world and so to discover the kinship between groups and their place in a natural classification. But along with this inquiry went always the question, What were the *agencies* that have been at work in the transformation of species? This is perhaps the question of more practical concern to us, for the agencies that have been at work in the past are doubtless at work today. It has been *easier,* however, to learn something fairly definite about the *course* of evolution than it has been to determine the factors at work. Moreover, it is doubtless true that a knowledge of lines of ancestry will aid us in the inquiry into the nature of these factors. It is not difficult then to understand why attention was concentrated so long on the data of comparative morphology.

Zoologists and paleontologists have nevertheless speculated abundantly on the causes of transformation, making use of such knowledge as has been available. So in this country Cope, Hyatt, and others have developed theories dealing with these problems. The theories of Cope and Hyatt proceed in part

along the lines laid down by the great French zoologist, Lamarck, and assume that the changes induced in an individual by habit and by the direct action of the environment are inherited. Little, even today, is known on this head, and however suggestive and valuable such theories are, it would seem that nothing certain can be learned from comparison alone. Darwin's theory of natural selection, of the selective influence of the environment, helps us to understand one great, universal attribute of organisms, viz., that structure in general is useful, is adaptive, and again why the descendents of a species should tend to split up into divergent races. But as to the underlying physiological processes concerned in the production of the initial differences between individuals, on which selection operates, it tells us nothing. Nor does it give us information which would enable us even to pick out with certainty the *kinds* of initial differences on which selection can operate. Lamarck, Darwin, and evolutionists in general have all along seen clearly that such problems can only be answered with the aid of *experiment*.

This word, "experiment," is the master-word to the understanding of the present era in zoology, but with the oncome of this era my sketch must come to an end. Wherever we look today, whether to studies revolving round the idea of species, or to those dealing with habit, or with anatomy, or with the tissues, or with the cell, everywhere we find that along with observation and comparison, experiment has entered in. In some fields the new method is easy to practise and is dominant, in others it is difficult and therefore only accessory. With the introduction of experiment it would seem that many questions which have been raised should find an answer. Certainly the outlook is hopeful.

CHAPEL HILL, N. C.

NOTE ON THE FUNDAMENTAL BASES OF DYNAMICS.

By Wm. Cain.

For some years there has been increasing dissatisfaction with the manner of presentation of the fundamental principles of dynamics, as given by text books, particularly for the use of engineering students. From the time of Newton down, mass of a body has been defined as "the quantity of matter in the body"—an admittedly ambiguous term.

Mass is likewise said to equal density times volume, or density equals mass divided by volume, which gives no precise conception of density until the idea of mass is made clear and precise.

Next in order comes the definition, force = mass × acceleration, which is likewise obscure until mass is quantitatively defined.

However, as an illustration, if a body of mass m is supposed to fall *in vacuo* under the *force of the* attraction of gravitation, whose measure is the weight W in pounds (say), the acceleration being g ft. per second per second, then the above equation takes the well known form,

$$W = mg;$$

whence $m = W/g$

so that finally it is seen that mass is directly proportional to weight and inversely proportional to the acceleration of gravity. Also, since W varies directly as g, the ratio W/g is constant for the same body for all points *on* or *in* the earth, and it is now realized clearly that mass is something pertaining to a body that does not alter with its position.

Now it has always seemed to the writer that it would be more logical to start with this precise conception of mass; in other words, define m as W/g, so that there will be no ambiguity, from the start, in ideas of mass, density and force. If this is done, however, it is very important to explain how W is to be found; for the weight of a body, as estimated by an equal armed balance is not usually the same as that given by a spring balance,

and it is well as a preliminary to the subject of dynamics to precisely describe the two methods of weighing and under what conditions they differ.

In what follows, the writer desires to acknowledge his indebtedness to an article by Prof. William Kent in "Science" for May 5th, 1911, entitled, "Notes on the Preliminary Report of the Committee on the Teaching of Mathematics to Students of Engineering." The present article might very well bear the same title, for its inspiration has come through reading the parts of the report given by Professor Kent and his valuable criticism thereon. The great value of the Report and Notes in outlining a method of presenting the first principles of dynamics, is acknowledged. But the writer believes the matter can be cast into a simpler and more logical form and he will endeavor, in what follows, to carry out this idea by suggesting such an outline of parts of the subject where amendment seems desirable.

(1) Mechanics treats of matter, at rest or in motion, under the action of force.

(2) The phrase, "weight of a body," is unfortunately used in two senses (1) to indicate the quantity of matter in the body, (2) to mean the force of attraction of the earth at the place on the body. To avoid confusion it is often advisable to specify the meaning intended. Thus a piece of matter weighing a pound may be called a pound of matter or a pound mass, whereas the force of attraction of the earth on it will be called a pound force. Similarly we can speak of a ton of matter and a ton force.

(3) The "British Unit" of weight is the quantity of matter in a certain piece of platinum and is called a pound. The "French Unit" is called the kilogram.

Copies of either standard, together with multiples and fractional parts of the same, will be called "a set of standard weights."

(4) To weigh a body on *an equal armed balance,* the body is put in one scale pan and is balanced by a certain number of standard weights (metal pieces) in the other scale pan. By this method, it is seen that the body will "weigh" the same at any latitude or altitude. Since the attraction of the earth on a

body varies both with the latitude and altitude, it is evident that the equal armed balance does not indicate, everywhere, the attractive force of the earth on the body.

The same remark applies to any lever balance or platform scales.

(5) Suppose a *spring balance* to be graduated with a set of standard British weights at sea level at latitude 45° where $g = 32.174$ ft. pr. sec. pr. sec. is the acceleration due to gravity. Now suppose a certain body there, when hung from the spring balance, to depress the pointer until it reads W lbs., then the attraction of the earth, at this point, for the body is exactly W pounds force.

Similarly, if the body is hung from this same "standard" spring balance at any other point on the earth, although the pointer may not read the same as before, still it indicates exactly the force with which the body is attracted by the earth at the place. This is the *true weight* of, or the pull of the *earth* on, the body and is the only one to be considered where great scientific accuracy is required.

(6) Call the weight of the body at the second place W_1 and the acceleration due to gravity g_1 ft. pr. sec. pr. sec.; then since it is an Experimental Fact that weight varies with acceleration,

$$\frac{W_1}{g_1} = \frac{W}{g} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This simple equation gives the solution to a number of problems involving weights at different latitudes.

(7) Thus, if the standard spring balance has been graduated at sea level at latitude 45° and a body weighs there W pounds, it will weigh at the equator, at sea level, where $g = 32.0894$,

$$W_1 \quad \frac{32.0894}{32.174} W = 0.99737\, W \text{ (lbs.)}$$

If $W = 10000$ lbs., $W_1 = 9973.7$ lbs., a difference of only 26.3 lbs. in 10000; so that for ordinary commercial or engineering purposes the difference is negligible. It is to be noted that the

body which weighs 10000 lbs. at 45° latitude, will weigh, on an equal armed balance, 10000 lbs. anywhere. Such a balance, or any lever balance, will thus give approximate results, which are usually near enough for commercial or most engineering purposes.

(8) To find the difference in weights as measured on "the standard spring balance" at any two points, let W_1 and g_1 represent the weight and gravity acceleration at one point, W_2 and g_2 similar quantities for the other point; then,

$$\frac{W_1}{g_1} = \frac{W_2}{g_2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Thus if a quantity of tea weighs $W_2 = 1$ lb. at the equator, where $g_2 = 32.09$, it will weigh at London where $g_1 = 32.19$

$$W_1 = \frac{32.19}{32.09}(1) = 1.003 \text{ lb.}$$

(9) Similarly, if any heavy body suspended from a wire, stretches it an amount e at the equator, it will stretch it $1.003e$ at London.

(10) The steam pressure that will just lift a certain body at London, will be 1.003 times the steam pressure, at the same temperature, that will lift the same body at the equator. Otherwise, by proportion, the *same* steam pressure will lift a body at the equator weighing 1.003 times as much as at London, if the weighing, in this instance, is done on an equal armed balance or its equivalent at both places. In fact, adopting the notation of (8), if the steam can just lift a body weighing W lbs. on the *spring balance* at London, by assumption, it exerts the same pressure,

$$W_1 = \frac{g_1}{g_2} W_2 = \frac{32.19}{32.09} W_2 = 1.003\, W_2$$

at the equator.

Here W_2 is the spring balance weight of the same body at the equator. Hence a second body weighing 1.003 times the

first will just be lifted by the same steam pressure at the equator.

(11) Another simple illustration will be given. The work of raising a body of weight W lbs. at sea level, at latitude 45°, h feet, is (Wh) ft. lbs. At this place, call the acceleration due to gravity g, at a second place g_1; whence the attraction of the earth on the same body at the second place is by (1)

$$W_1 = \frac{g_1}{g} W$$

Hence the work of lifting it, at the second place, is, in ft. lbs.,

$$W_1 h = \frac{g_1}{g} (Wh)$$

(12) MASS. Mass of a body means the quantity of matter in the body, which is not supposed to alter in amount by changing the position of the body relative to the earth or to be affected by the expansion or contraction of the body. Body here refers to a limited portion of a gas or liquid or any solid body.

Now by the experimental law, eq. (1) the ratio W/g of the weight of the body, as given by a spring balance, to the acceleration due to gravity at any point within the sphere of the earth's attraction, *is constant.* Hence *mass,* which is likewise unalterable by a change of place, is proportioned to W/g.

In the engineers' system it is usual to write for the mass m, the equality,

$$m = \frac{W}{g} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

so that, in this system, W/g can be regarded as the measure of the mass. For the same place, it varies directly with the weight.

We have now a precise measure of mass and can appreciate what properties of matter the word mass includes.

(13) The term *"density"* can now be defined as the quotient of mass by volume.

(14) The word *"force"* may be simply defined as a push or a pull.

(15) From sq. (3), we have, $W = mg$.

The fundamental formula of mechanics is,

$$F = m\,a \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where F is the force acting on the body whose mass is m and acceleration a, the force and acceleration being in the same direction.

In the engineers' system of units, when gravity is the force, acting (of course, vertically) $F = W$ lbs., $a = g$, giving the previous formula as a special case of (4).

(4) can likewise be written,

$$F = \frac{W}{g}\,a \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where F and W are expressed in pounds, a and g, in feet per second per second.

(16) From (4) other well known formulas as, $F\,t = m\,v$; $F\,s = \frac{1}{2}\,m\,v^2$, can at once be derived.

(17) Newton's three laws may be stated and commented on at this stage. Formula (4) is the symbolical expression of one law. Let us make an immediate application of the third law, "to every action, there is always an equal and contrary reaction."

Thus let a perfectly smooth particle of mass m strike a second similar particle of mass m, both moving in the same direction along the lines of the centers of the particles. In the infinitesimal time dt, call the accelerations of the particles a and a_1 respectively, since they act in opposite directions, a and a_1 have opposite signs. When by Newton's law of action and reaction

$$-m\,a = m_1\,a_1; \quad \frac{m}{m_1} = -\frac{a_1}{a}$$

In a recent work on Analytic Mechanics by Barton, p. 196, the author follows Mach in giving the last equation as a definition of mass. It is submitted that it is simpler to define mass as in (12), then force as in (15), whence the above formula is seen to be a derived one.

(18) In formula (5) above, W is supposed to be the weight of the body in pounds as determined by a standard spring balance, used at the place of the body. By formula (1), W can be taken as the weight by spring balance at 45° latitude, provided g is put = 32.174. But W will be the same if the body is weighed on an equal armed balance anywhere (4); hence, supposing the body weighed in the usual way on a lever balance, formula (5) can be written in the exact form,

$$F = \frac{W}{32.174} a \quad \ldots\ldots\ldots\ldots\ldots (6)$$

This is evidently the most practical form of equation (5).

(19) BRITISH ABSOLUTE SYSTEM. In the British engineers' system, with which we have dealt so far, the pound weight at sea level at latitude 45° has been taken as the unit of force and the unit mass is derived from the equation

$$m = \frac{W}{32.174} = 1;$$

whence the unit mass is the mass of a body weighing 32.174 lbs. on a standard spring balance at sea level, at 45° latitude, or on a lever balance anywhere. In the *British absolute system* the mass of the piece of metal, called a pound weight, is taken as the unit of mass, and the unit of force is defined as that force which, acting for one second on the mass of the pound piece of metal generates in it a velocity of one foot per second.

From numerous experiments it is known that if a body weighing one pound, on a lever balance, fall freely for one second, at sea level, at latitude 45°, it will acquire a velocity of $g = 32.174$ feet per second. The force acting on the body is 1 pound. If this force was $\frac{1}{g}$ of a pound, the body at the end of one second, would have a velocity of one foot per second. Hence the unit of force, at the place, is $\frac{1}{g}$ of a pound (force)

or slightly less than half an ounce avoirdupois. Such a force has been called a *poundal.*

By equation (1) putting $W = 1$, $g = 32.174$, we have

$$\frac{W_1}{g_1} = \frac{1}{32.174},$$

In this equation, W_1 represents the attraction of the earth on the metal piece, called a pound weight, at any place where the acceleration is g_1. Reasoning as before, the force W_1 acting freely on the metal piece will cause it to acquire in one second a velocity of g_1 feet per second; hence the force

$$\frac{W_1}{g_1} = \frac{1}{32.174} \text{ pound} = 0.031081 \text{ pound},$$

will produce in the body a velocity of one foot per second at the place considered. The unit of force, the poundal, in the absolute system, is thus constant and it may be thought of as a pull or a push of a little less than ½ ounce. Let the student realize that in the absolute system, in connection with the formula $F = m\,a$, that m is expressed by the same number that represents the weight in pounds of the body as found (anywhere) by an equal-armed balance, and that F is expressed in poundals, where a poundal is 0.031081 pound force.

An answer in poundals can be readily expressed in pounds of force by dividing by 32.174 or multiplying by 0.031081. In Technical Mechanics, it is well to give the absolute system in an Appendix, for although the engineer student will not use it in his ordinary work, still a slight study of the absolute system will enable one to read valuable works that otherwise might offer difficulties.

The same remarks apply to the French C. G. S. system, which may be analyzed as above. It is well to bear in mind that in any absolute system, the lever balance always measures mass, whereas in the engineers' system the spring balance measures the attraction of the earth (weight).

CHAPEL HILL, N. C.

NOTES ON THE DISTRIBUTION OF THE MORE COMMON BIVALVES OF BEAUFORT, N. C.

(Published by permission of the U. S. Commissioner of Fish and Fisheries)

By Henry D. Aller.

Director U. S. Bureau of Fisheries Laboratory, Beaufort, N. C.

While studying for systematic purposes the approximately ninety species of bivalve molluscs which are found in the vicinity of the Fisheries Laboratory at Beaufort, N. C., it seemed desirable to consider which were available for scientific work involving the use of living animals. A species represented at the laboratory by a few specimens dredged in the deeper water offshore, or by valves secured on the beaches, would be useless for such research. Also species which might be abundant in the vicinity but of which the habitat is not sufficiently well known to permit of their being collected when wanted would be equally useless. It is the purpose of this paper to indicate which species are available in a living condition, specific localities where they may be found, and when possible something in reference to their abundance. A paper of this kind cannot be complete, for further work will necessarily extend such information. It can only include what is known at the time by the writer. It is hoped that it may be of service to prospective investigators by pointing out what material they would have at their service under ordinary conditions.

For the identification of the species and for assistance with the literature I am very largely indebted to Doctors Dall and Bartsch of the U. S. National Museum.

FAMILY SOLENOMYACIDÆ.

Genus Solemya Lamarck, 1818.

Solemya velum Say.

Solemya velum Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 317, 1822.
Solenomya velum, Dall, Bull. 37, U. S. Nat. Mus., p. 46, fig. 3, 1889.

Abundant on the sandy shoals west of the laboratory. Early records indicate that it is found on Bird Shoal. It has been

found recently near Gallants Point across the channel leading from the inland waterway to Beaufort, and it probably occurs on sandy shoals throughout the vicinity. It is easily obtained at low water, living in sand near the surface. Collected on Shark Shoal, 1912.

FAMILY NUCULIDÆ.

Genus Nucula Lamarck, 1799.

Nucula proxima Say.

Nucula proxima Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 270, 1822; Dall, Bull. 37, U. S. Nat. Mus., p. 42, pl. 56, fig. 4, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 574, 1898.

Little attention has been given to the collection of living specimens. Live animals have been dredged, during 1912, near the eastern end of Bogue Sound, and dead valves are found in other localities. It is believed that careful search would yield abundant material.

FAMILY ARCIDÆ.

Genus Arca (Linnæus) Lamarck, 1799.

Subgenus Noëtia Gray, 1840.

Arca (Noëtia) ponderosa Say.

Arca ponderosa Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 267, 1822.

Arca (Noëtia) ponderosa, Dall, Bull. 37, U. S. Nat. Mus., p. 40, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 633, 1898.

Of the several species of this genus which belong to the Beaufort fauna this is the most abundant. It is a large form and may be readily obtained at any time. It lives a few inches below the surface of the ground, in firm sand or mud. One specific collecting ground is the shoals west of the laboratory.

Subgenus Scapharca (Gray) Dall.

Arca (Scapharca) transversa Say.

Arca transversa Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 269, 1822; Dall, Bull. 37, U. S. Nat. Mus., p. 40, pl. 56, fig. 2, 1889.

Scapharca (Scapharca) transversa, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 645, 1898.

Several specimens in the laboratory collection are recorded as having been collected above Horse Island on mud bottom. The animal, immature, is recorded from Pivers Island and from Bogue Sound. A few other specimens have been taken in the dredge in the vicinity of Beaufort. Valves are found rather commonly.

Arca (Scapharca) campechensis Dillwyn.

Arca campechensis Dillwyn, Descr. Cat. Rec. Sh., I., p. 288, 1817 (Syn. partim exclus.), Jamaica and Carolina.

Arca pexata Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 268, 1822; Dall, Bull. 37, U. S. Nat. Mus., p. 40, 1889.

Scapharca (Argina) campechensis, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 650, 1898.

Small examples have been dredged in Bogue Sound; one specimen in channel south of Green Rock. As many valves are in the laboratory collection, further search will probably reveal good collecting grounds.

FAMILY PINNIDÆ.

Genus Atrina Gray.

Atrina rigida (Dillwyn).

Pinna rigida (Solander MSS.) Dillwyn, Cat., p. 327, 1817.

Atrina rigida, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 663, 1898; Grave, B. H., Bull. Bur. Fish., vol. 29, p. 411, 1911.

The species is fairly abundant. The usual collecting ground is in the vicinity of Pivers Island. The form may be found at about low water mark. The valves usually project a short distance above the surface of the ground.

The anatomy and physiology of this species have been made the subject of a report by Grave, loc. cit.

FAMILY PTERIIDÆ.

Genus Pteria Scopoli, 1777.

Pteria colymbus (Bolten).

Pinctada colymbus Bolten, Mus. Boltenian., p. 167, 1798.

Avicula atlantica, Dall, Bull. 37, U. S. Nat. Mus., p. 36, 1889.

Pteria colymbus, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 670, 1898.

Living animals are occasionally found. Systematic search would probably reveal a moderate number. It is found attached to suitable objects in the water.

FAMILY OSTREIDÆ.

Genus Ostrea (Linnæus) Lamarck.

Ostrea virginica Gmelin.

Ostrea virginica Gmelin, Syst. Nat., p. 3336, 1792; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 687, 1898.

This abundant species needs only inclusion in this list.

FAMILY PECTINIDÆ

Genus Pecten Müller.

Pecten (Plagioctenium) gibbus (Linnæus).

Ostrea gibba Linnæus, Syst. Nat., Ed. 10, No. 172, p. 698, 1758.
Pecten dislocatus Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 260, 1822.
Pecten (Plagioctenium) gibbus, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 745, 1898.

This species is found in sufficient quantities to form a local food supply of considerable value. The adult form is free-swimming and may be found at various times in different localities. Some observations on the habits of the varietal form *Pecten dislocatus* Say have been published by Grave, B. H., Biol. Bull., vol. 16, No. 5, April, 1909.

FAMILY ANOMIIDÆ.

Genus Anomia (Linnæus) Müller.

Anomia simplex Orbigny.

Anomia simplex Orbigny, Moll. Cubana, vol. 2, p. 367, pl. 38, figs. 31-33, (1845 Spanish edition), 1853; Dall, Bull. 37, U. S. Nat. Mus., p. 32, pl. 53, figs. 1-2, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 784, 1898.

The animal is common in the vicinity. One collecting ground is the shoals west of the laboratory. It is found attached to other shells, as *Ostrea, Tagelus, Macrocallista.*

FAMILY MYTILIDÆ.

Genus Mytilus (Linnæus) Bolten.

Mytilus (Hormomya) exustus Linnæus.

Mytilus exustus Linnæus, Syst. Nat., Ed. 10, p. 705, 1758; Dall, Bull. 37, U. S. Nat. Mus., p. 38, 1889.

Mytilus (Hormomya) exustus, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 788, 1898.

This comparatively small species is found in fairly large numbers on the breakwater at Pivers Island, associated with *Modiolus demissus* (Dillwyn). It can probably be found on any of the several breakwaters in the vicinity of Beaufort.

Genus Modiolus Lamarck, 1799.

Modiolus (Brachydontes) demissus (Dillwyn).

Mytilus demissus (Solander MSS.) Dillwyn, Descr. Cat. Rec. Shells, vol. 1, p. 314, 1817.

Modiola plicatula, Dall, Bull. 37, U. S. Nat. Mus., p. 38, pl. 54, fig. 1, 1889.

Modiolus (Brachydontes) demissus, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 794, 1898.

Very abundant on the breakwater and on muddy ground between tide marks at Pivers Island. Abundant about the western end of Town Marsh. Its natural habitat at Beaufort seems to be between tide marks among the roots of vegetation along the edges of salt marshes. It is the common mussel at Beaufort.

Modiolus tulipus Lamarck,

Modiola tulipa Lamarck, An. sans Vert., vol. 6, p. 111, 1819; Dall, Bull. 37, U. S. Nat. Mus., p. 38, 1889.

Modiolus tulipus, Dall & Simpson, Bull. U. S. Fish Com. for 1900, vol. 20, pt. 1, p. 470.

The species has been found at the railroad pier at Morehead City and in the vicinity of Pivers Island. So far living matrial has not been found abundantly.

Genus Lithophaga Bolten, 1798.

Lithophaga bisulcata (Orbigny).

Lithodomus bisulcatus Orbigny, Moll. Cubana, vol. 2, p. 333, pl. 28, figs. 14-16, 1847 (Spanish edition and atlas, 1845).

Lithophagus bisulcatus, Dall, Bull. 37, U. S. Nat. Mus., p. 38, 1889.

Lithophaga (Diberus) bisulcata, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 801, 1898.

Living animals are abundant near the Norfolk Southern railroad pier at Morehead City. Their occurrence is not known elsewhere about Beaufort Harbor. The species is found burrowing into pieces of coral and soft rock. The scarcity of suitable material into which the individuals may burrow accounts for the limited distribution about Beaufort. The maximum length noted is 46 mm.

FAMILY TEREDINIDÆ.

Genus Xylotrya Leach.

Xylotrya gouldi Bartsch.

Xylotrya gouldi Bartsch, Proc. Biol. Soc. Wash., vol. 21, p. 211, 1908; Sigerfoos, Bull. Bur. Fish., vol. 27, p. 194, 1908.

This species is found abundantly in wood such as piling, exposed to the action of sea water.

FAMILY PHOLADIDÆ.

Genus Martesia Leach, 1825.

Martesia (Section Diplothyra) smithii (Tryon).

Diplothyra smithii Tryon, Proc. Acad. Nat. Sci. Phila., vol. 14, p. 201, 1862.

Martesia (Section Diplothyra) smithii, Dall, Bull. U. S. Nat. Mus., p. 72, 1889.

A small mollusc, which has been found abundantly at the railroad pier at Morehead City.

FAMILY MACTRIDÆ.

Genus Spisula Gray, 1838.

Spisula similis (Say).

Mactra similis Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 309, 1822.

Mactra solidissima var. similis, Dall, Bull, 37, U. S. Nat. Mus., p. 62, 1889.

The living animal is taken in the dredge, but specific localities are not recorded. It has been found, 1912, on the seashore near Fort Macon.

Genus Mulinia Gray.

Mulinia lateralis (Say).

Mactra lateralis Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 309, 1822; Dall, Bull. 37, U. S. Nat. Mus., p. 62, pl. 69, fig. 8, 1889.

Mulinia lateralis, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 4, p. 901, 1898.

The species is found at Pivers Island and on a shoal west of that island. Fairly abundant.

FAMILY SOLENIDÆ.

Genus Solen (Linnæus) Scopoli, 1777.

Solen viridis Say.

Solen viridis Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 316, 1822.
Solen (Ensis) viridis, Dall, Bull. 37, U. S. Nat. Mus., p. 72, 1889.
Solen viridis, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 952, 1900.

A few animals have been collected at Beaufort. One specific collecting ground is the shoals west of the laboratory.

FAMILY DONACIDÆ.

Genus Donax (Linnæus).

Donax variabilis Say.

Donax variabilis Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 305, 1822; Dall, Bull. 37, U. S. Nat. Mus., p. 58, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 969, 1900.

The specific collecting ground is the seashore at Fort Macon. At times small areas near the water's edge may be found where the animals occur in large numbers.

FAMILY PSAMMOBIIDÆ.

Genus Tagelus Gray.

Tagelus gibbus (Spengler).

Solen gibbus Spengler, Skrivt. Nat. Selsk., vol. 3, p. 104, 1794.

Tagelus gibbus, Dall, Bull. 37, U. S. Nat. Mus., p. 58, pl. 55, fig. 3, pl. 56, fig. 3, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 983, 1900.

Collecting grounds: In muddy sand just south of railroad pier at Morehead City, Pivers Island, shoals west of Pivers Island. The animal may be found buried at a depth of a foot or more in the ground between tide marks. Shells are common on Shark Shoal.

Tagelus divisus (Spengler).

Solen divisus Spengler, Skrivt. Nat. Selsk., vol. 3, p. 96, 1794.

Tagelus divisus, Dall, Bull. 37, U. S. Nat. Mus., p. 58, pl. 56, fig 5, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 984, 1900.

Collecting grounds: Dredging in Bogue Sound, vicinity of Pivers Island, near Gallants Point across the channel leading from inland waterway to Beaufort, south of railroad pier at Morehead City, muddy sand about western end of Town Marsh. Abundant.

FAMILY SEMELIDÆ.

Genus Semele Schumacher.

Semele proficua (Pulteney).

Tellina proficua Pulteney, Hutchin's Dorset, p. 29, pl. 5, fig. 4, 1799.

Semele proficua, Dall & Simpson, Bull. U. S. Fish Com. for 1900, vol. 20, pt. 1, p. 477; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 991, 1900.

The species is common on Pivers Island, and it is also obtained by dredging in Bogue Sound.

Genus Abra (Leach) Lamarck, 1818.

Abra æqualis (Say).

Amphidesma æqualis Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 307, 1822.

Abra æqualis, Dall, Bull. 37, U. S. Nat. Mus., p. 62, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 998, 1900.

It may be obtained by dredging in Bogue Sound. Live material is not recorded as common. Valves of the species appear to be abundant throughout the vicinity of the laboratory.

FAMILY TELLINIDÆ.

Genus Tellina (Linnæus) Lamarck, 1799.

Tellina alternata Say.

Tellina alternata Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 275, 1822; Dall, Bull. 37, U. S. Nat. Mus., p. 60, 1889.

Tellina (Eurytellina) alternata, Dall, Trans Wagner Inst. Sci., vol. 3, pt. 5, p. 1029, 1900.

The live animal is found in Beaufort Harbor but specific localities are not recorded.

Genus Macoma Leach, 1819.

Macoma tenta (Say).

? Psammobia lusoria Say, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 304, 1822; not of Conrad, 1840.

Tellina tenta Say, Am. Conch., pl. 65, fig. 3, 1834.

Macoma tenta, Dall, Bull. 37, U. S. Nat. Mus., p. 60, pl. 56, fig. 10, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 1049, 1900.

Collecting ground: Dredging in Bogue Sound. Material not known to be abundant.

FAMILY PETRICOLIDÆ.

Genus Petricola Lamarck, 1801.

Petricola (Rupellaria) typica (Jonas).

Choristodon typicum Jonas, Zeitschr. Mal., i., p. 185; Beitr. Molluskol., p. 1, pl. 7, fig. 3, 1844.

Petricola (Choristodon) robusta, Dall, Bull. 37, U. S. Nat. Mus., p. 58, 1889; not of Sowerby.

Petricola (Rupellaria) typica, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 1059, 1900.

Collecting ground at railroad pier, Morehead City.

Petricola (Petricolaria) pholadiformis Lamarck.

Petricola pholadiformis Lamarck, An. sans Vert., v., p. 505, 1818; Dall, Bull. 37, U. S. Nat. Mus., p. 58, pl. 59, fig. 15, pl. 64, fig. 140a, 1889.

Petricola (Petricolaria) pholadiformis, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 1061, 1900.

The animal is found in the mud (or turf) in the vicinity of the jetties at Fort Macon; also about the western end of Town Marsh. It lives near the surface between tide marks. It is also found in rocks at the railroad pier at Morehead City.

Petricola dactylus Sowerby.

Petricola dactylus Sowerby, Genera, Petricola, fig. 3, 1823.

Petricola pholadiformis var. dactylus, Dall, Bull. 37, U. S. Nat. Mus., p. 58, 1889.

Specimens are found at the railroad pier at Morehead City. The species is probably more widely distributed in the vicinity.

FAMILY VENERIDÆ.

Genus Dosinia Scopoli, 1777.

Dosinia discus (Reeve).

Artemis discus Reeve, Conch. Icon., vol. 6, Artemis, pl. 2, fig. 9, 1850.

Dosinia (Dosinidia) discus, Dall, Proc. U. S. Nat. Mus., No. 1312, p. 379, pl. 12, fig. 1, pl. 13, fig. 1, 1902; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 6, p. 1232, 1903.

Material very abundant in the sand flats about Pivers Island. It is found buried in sand nearly a foot below the surface, near the low water mark. It could probably be found on sandy shoals generally in the vicinity.

Genus Macrocallista Meek, 1876.

Macrocallista nimbosa (Solander).

Venus nimbosa Solander, Portland Cat., p. 175, No. 3761, 1786.

Cytherea (Callista) gigantea, Dall, Bull. 37, U. S. Nat. Mus., p. 56, 1889.

Macrocallista nimbosa, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 6, p. 1254, 1903.

One specific collecting ground is the shoals west of Pivers Island. It is also found on Shark Shoal. Charles Hatsel states that it is common on Bird Shoal and that it lives three or four inches below the surface in sand between tide marks.

Genus Chione Megerle von Muhlfeld, 1811.

Chione cancellata (Linnæus).

Venus cancellata Linnæus, Syst. Nat., Ed. 12, p. 1130, 1767; Dall, Bull. 37, U. S. Nat. Mus., p. 54, 1889.

Chione cancellata, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 6, p. 1290, 1903.

Specific collecting grounds are about the laboratory pier at Pivers Island and on the old oyster reef across the channel from the east side of Pivers Island. It is a very abundant species, living on muddy or shelly bottom, near or on the surface, at about low water mark.

Genus Venus (Linnæus) Lamarck.

Venus mercenaria (Linnæus).

Venus mercenaria Linnæus, Syst. Nat., Ed. 10, p. 686, 1758.

Venus mercenaria, Dall, Bull. 37, U. S. Nat. Mus., p. 54, pl. 55, fig. 7,

pl. 71, figs. 1, 3, 1889; Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 6, p. 1311, 1903.

The species may be easily obtained at or near the surface on muddy or shelly bottom between tide marks almost anywhere in the vicinity. Very abundant.

FAMILY CARDIIDÆ.

Genus Cardium (Linnæus) Lamarck.

Subgenus Trachycardium Mörch, 1853.

Cardium (Trachycardium) isocardia Linnæus.

Cardium isocardia Linnæus, Syst. Nat., Ed. 10, p. 679, 1758; Dall, Bull. 37, U. S. Nat. Mus., p. 52, 1889.

Cardium (Trachycardium) isocardia, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 1085, 1900.

The living animal has been dredged, during 1912, near the eastern end of Bogue Sound.

Cardium (Trachycardium) muricatum Linnæus.

Cardium muricatum Linnæus, Syst. Nat., Ed. 10, p. 680, 1758; Dall, Bull. 37, U. S. Nat. Mus., p. 52, 1889.

Cardium (Trachycardium) muricatum, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 1089, 1900.

The species has been collected in the vicinity of Pivers Island, at the railroad pier at Morehead City, and dredged near the eastern end of Bogue Sound.

Subgenus Dinocardium Dall, 1900.

Cardium (Dinocardium) robustum Solander.

Cardium robustum Solander, Portland Catalogue, p. 58, 1786, after Lister, Hist. Conch., pl. 328, fig. 165, 1770.

Cardium magnum, Dall, Bull 37, U. S. Nat. Mus., p. 52, 1889.

Cardium (Cerastoderma) robustum, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 1099, 1900.

Living animals have been found on Bird Shoal in Beaufort Harbor. The valves of this species are the most conspicuous ones on the seashore at Fort Macon.

Subgenus Lævicardium Swainson, 1840.

Cardium (Lævicardium) mortoni Conrad.

Cardium mortoni Conrad, Journ. Acad. Nat. Sci. Phila., vol. 6, p. 259, pl. 10, figs. 5, 6, 7, 1830.

Cardium (Liocardium) mortoni, Dall, Bull. 37, U. S. Nat. Mus., p. 54, pl. 58, fig. 8, 1889.

Cardium (Lævicardium) mortoni, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 5, p. 1111, 1900.

The live animal may be obtained on Pivers Island, on the shoals west of that island, and in the dredge in the vicinity of Beaufort.

Family Lucinidæ.

Genus Phacoides Blainville, 1825.

Phacoides (Parvilucina) crenella Dall.

Phacoides (Parvilucina) crenella, Dall, Proc. U. S. Nat. Mus., No. 1237, Synopsis Lucinacea, pp. 810, 825, pl. 39, fig. 2, 1901.

Lucina crenulata, Dall, Bull. 37, U. S. Nat. Mus., p. 50, 1889.

Living material could probably be found abundantly, but the laboratory records are not sufficient to verify the assumption. A rather small species.

Genus Divaricella von Martens.

Divaricella quadrisulcata (Orbigny).

Lucina quadrisulcata Orbigny, Voy. Am. Mer., Moll., p. 584, 1846.

Lucina (Divaricella) quadrisulcata, Dall, Bull. 37, U. S. Nat. Mus., p. 50, 1889.

Divaricella quadrisulcata, Dall, Trans. Wagner Inst. Sci., vol. 3, pt. 6, p. 1389, pl. 51, fig. 1, 1903.

Valves are abundant and some entire animals have been collected at Beaufort. This species should not be confused with *D. dentata* Wood, which the writer has not found at Beaufort.

April, 1912.

THE GLOOMY SCALE, AN IMPORTANT ENEMY OF SHADE TREES IN NORTH CAROLINA.

By Z. P. Metcalf.

The gloomy scale is the most important insect enemy of shade trees in North Carolina. We are led to make this statement for two reasons: First, because it increases far more rapidly than any other insect attacking shade trees, and in the second place it is all but confined to the maples which have been so largely used for shade purposes along the streets of our cities and towns. The gloomy scale is rather closely related to the famous San Jose scale, which is so destructive to our fruit trees. Unlike the San Jose scale it is a native insect. We are led to believe this because the gloomy scale is very heavily parasitized, indicating that it has been established in this country for a long period of time. Then the fact that the scale has been found on a willow along a stream in Lincoln County is another very strong indication of its nativity.

The gloomy scale differs from the San Jose scale in another very vital respect, and that is that it is very much more difficult to control. We believe that this is due to the fact that the gloomy scale lives over the winter as a mature insect, while the San Jose scale lives over the winter as a half grown young. The latter condition enables us to apply very caustic insecticides at a time when the insect is weakest, and at the same time the tree is in a dormant condition so that it is not injured in the least. Then, too, the dorsal scale of the gloomy scale is much thicker and more closely applied to the ventral scale than is the case with the San Jose scale, so that the gloomy scale is especially well protected against any contact insecticide.

These facts forced themselves upon our attention soon after we commenced experiments for the control of this insect four years ago. We soon discovered that the remedies usually recommended for the San Jose scale would be of little or no use against this insect. As a matter of fact the mortality of the scale on some unsprayed trees was less than that of some trees

sprayed with the ordinary lime-sulphur, due perhaps to the fungicidal action of the lime-sulphur killing out the winter form of the red headed fungus, a rather common fungus disease of this insect.

The following winter we tried an extensive series of experiments with all of the manufactured insecticides at our command. These insecticides may be divided roughly into two classes,—the lime-sulphurs and the soluable oils. The lime-sulphurs are highly concentrated mixtures of various compounds of lime and sulphur, which are diluted with water to make mixtures of various strengths for different plants and for different seasons of the year. The soluable oils are essentially the heavier oils of the petroleum series together with a vegetable oil. When mixed with water they make a beautiful emulsion that may be used for spraying with perfect safety. The very day that the mixtures were applied it was evident that the lime-sulphurs would not be as effective as the soluable oils. The former dried on the bark in a very short time, while the latter remained moist for several hours. Thus the soluable oils were enabled to creep in around and under the thick closely-applied dorsal scale and suffocate the insect. While the lime-sulphurs were not able to penetrate the thick dorsal scale, and they dried so quickly that they could not creep under, so that they killed very few insects.

Examinations of the sprayed trees every three or four months until last fall showed that all of the soluable oils had been effective, killing at least 95 per cent. of the scale, while none of the lime-sulphurs had killed over 75 per cent. This represents the difference between an effective and a non-effective spray mixture.

Another point that has been brought out in the course of our investigations is the fact that the soft maples, red and silver, are injured more by this insect than the hard maples like the sugar and Norway. Careful inspection usually shows as high as 90 per cent of the soft maples infested, whereas it is very unusual to find as high as one per cent. of the hard maples infested. In this connection the following host plant list shows

what trees we may reasonably expect to suffer from the attacks of this insect, although it is probable that not all of the trees given will be seriously troubled.

Apple, (Pyrus malus L.) Several young trees growing under the overhanging branches of badly infested red maples found slightly infested.

Red Maple. (Acer rubrum L.) Generally infested.

Silver Maple. (Acer saccharinum L.) Uniformly and badly infested.

Sugar Maple. (Acer saccharum Marsh.) A few scattering individuals found infested, mostly very slightly.

Box Elder. (Acer negundo L.) A few infested.

Buckeye.. (Æsculus glabra Willd.) Slightly infested.

Japanese Chestnut. (Castanea sativa.) Badly infested .

Sycamore. (Platanus occidentalis L.) Slightly infested.

Water Oak. (Quercus nigra L.) A single tree slightly infested.

White Oak. (Quercus alba L.) A few trees slightly infested.

Iron-wood. (Carpinus caroliniana Walt.) A single badly infested tree.

Willow. (Salix sp.) A small badly infested tree found along a stream in Lincoln County.

Cottonwood. (Populus deltoidea Marsh.) Slightly infested tree.

American Elm. (Ulmus americana L.) Slightly infested.

Mulberry.. (Morus rubra L.) Badly infested.

The complete life history of this insect is yet to be worked out, and it is our intention to work this out this summer. We have determined, however, that the females give birth to living young, the first young from overwintering adults being born about the 10th of May. These young molt twice and reach maturity in summer and then give birth to living young. The exact number of generations each year is not known. Neither is the male insect known save for a brief description of two "male" dorsal scales given by Comstock in the original description of this insect. Comstock states that the insects beneath these scales were dead and much shrivelled. Strange to say,

we have never discovered any males, although we have inspected hundreds of trees, most of which were very badly infested, and certainly if males occurred in anyways normal proportions we would have discovered them. At other times we have examined and counted hundreds of scales on selected twigs, and found them all females. Of course parthenogenesis is a possibility, but it does not occur normally in nearly related species; and that leads us to believe that it does not occur here. Although we are almost forced to believe that fertilization, if it occurs at all, occurs in only one generation out of the several generations each year.

CAPTURE OF RALEIGH BY THE WHARF RAT.

By C. S. Brimley.

Three species of rats are commonly known as house rats; these are the Black Rat (Mus rattus), the Brown Rat or Wharf Rat (Mus norvegicus), and the Roof Rat (Mus alexandrinus). Of these, the black rat, formerly the common house rat of Europe, was introduced by the earliest settlers into North America, and in both countries has been practically exterminated by the wharf rat, a late comer. The roof rat, an inhabitant of the Mediterranean regions, has been introduced into the Southern States, as well as into most warm countries, and appears to hold its own against the wharf rat better than the black rat, which it resembles in all but color. In the tropics, however, all three species exist side by side.

In characteristics the three differ as follows: the black rat is sooty black above, somewhat lighter below, and the tail is usually longer than the head and body; the roof rat is brownish gray above, yellowish white below, and has the tail also longer than the head and body; the wharf rat is browner than the roof rat above, and much less white below, (the white being more ashy), while the tail is usually decidedly shorter than the head and body. It is also a considerably heavier animal than the two others. An extra large roof rat will measure 17 inches in total length, of which about 9½ inches would be tail, while an average wharf rat of the same total length would have the tail only about 7 inches, or less.

Up to 1909 the only house rats I had seen in Raleigh were the roof rats, but in that year a wharf rat was brought up to the State Museum some time late in March, the first I had seen since I left England in 1880. During the next year I occasionally saw a dead one that had been thrown on the street, but during 1911 they leaped into prominence. In that year the old cotton platform near the Seaboard freight depot was torn up, and it was the general opinion that multitudes of rats that had been dwelling beneath were then scattered abroad. At any

rate, complaints began to come in to the newspapers about a strange kind of rat that was overrunning Raleigh, and slaughtering young chickens *ad libitum,* and most wonderful stories became current about them. They were as big as cats; large ones weighed three pounds; whenever a hen and chickens were placed in a rat-proof coop resting on the ground, the rats carefully surveyed the coop, and then dug tunnels underneath it, always coming up exactly underneath the old hen, and killing all her chickens without ever showing themselves. Wild as these stories were, they had a foundation in fact, this species being a most inveterate destroyer of small chickens. One of the neighbors, for instance, only a few days ago left a chicken coop open one night and the rats got no less than twenty-six of the thirty chickens in the coop.

They reached my vicinity, a mile from the Seaboard depot, last August, and I have been catching specimens off and on ever since. So far I have not lost any chickens by them, but there is no doubt they are a most serious factor in chicken raising in Raleigh at present.

In habits they are strongly inclined to burrow, while the other two species are climbers, a roof rat when disturbed preferring to seek safety upwards, a wharf rat downwards. The largest specimen I have weighed did not exceed a pound, and several other big ones only reached 14 ounces.

Why they have not overrun Raleigh before it is hard to say, as they are known to have been at Beaufort as far off as 1870 (Coues), and at Newbern in 1885 (H. H. Brimley), while they have been doubtless plentiful at Norfolk and Baltimore ever since Raleigh has been in existence, and specimens have almost certainly been brought in on freight cars every year. We hear that they overran Kinston in a similar manner some years ago.

So far as my premises were concerned, the roof rats had apparently left before the wharf rats came in. It is known however that the roof rat interbreeds with the black rat, and it is claimed that it also does with the wharf rat. However that may be, I have caught several specimens since last fall that were ap-

CAPTURE OF RALEIGH BY THE WHARF RAT.

By C. S. Brimley.

Three species of rats are commonly known as house rats; these are the Black Rat (Mus rattus), the Brown Rat or Wharf Rat (Mus norvegicus), and the Roof Rat (Mus alexandrinus). Of these, the black rat, formerly the common house rat of Europe, was introduced by the earliest settlers into North America, and in both countries has been practically exterminated by the wharf rat, a late comer. The roof rat, an inhabitant of the Mediterranean regions, has been introduced into the Southern States, as well as into most warm countries, and appears to hold its own against the wharf rat better than the black rat, which it resembles in all but color. In the tropics, however, all three species exist side by side.

In characteristics the three differ as follows: the black rat is sooty black above, somewhat lighter below, and the tail is usually longer than the head and body; the roof rat is brownish gray above, yellowish white below, and has the tail also longer than the head and body; the wharf rat is browner than the roof rat above, and much less white below, (the white being more ashy), while the tail is usually decidedly shorter than the head and body. It is also a considerably heavier animal than the two others. An extra large roof rat will measure 17 inches in total length, of which about 9½ inches would be tail, while an average wharf rat of the same total length would have the tail only about 7 inches, or less.

Up to 1909 the only house rats I had seen in Raleigh were the roof rats, but in that year a wharf rat was brought up to the State Museum some time late in March, the first I had seen since I left England in 1880. During the next year I occasionally saw a dead one that had been thrown on the street, but during 1911 they leaped into prominence. In that year the old cotton platform near the Seaboard freight depot was torn up, and it was the general opinion that multitudes of rats that had been dwelling beneath were then scattered abroad. At any

rate, complaints began to come in to the newspapers about a strange kind of rat that was overrunning Raleigh, and slaughtering young chickens *ad libitum,* and most wonderful stories became current about them. They were as big as cats; large ones weighed three pounds; whenever a hen and chickens were placed in a rat-proof coop resting on the ground, the rats carefully surveyed the coop, and then dug tunnels underneath it, always coming up exactly underneath the old hen, and killing all her chickens without ever showing themselves. Wild as these stories were, they had a foundation in fact, this species being a most inveterate destroyer of small chickens. One of the neighbors, for instance, only a few days ago left a chicken coop open one night and the rats got no less than twenty-six of the thirty chickens in the coop.

They reached my vicinity, a mile from the Seaboard depot, last August, and I have been catching specimens off and on ever since. So far I have not lost any chickens by them, but there is no doubt they are a most serious factor in chicken raising in Raleigh at present.

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parently wharf rats, but had tails longer than the head and body as in the roof rat.

Whether the wharf rat will continue to be the house rat of Raleigh in future, or whether local conditions which must certainly have been favorable to the roof rat in the past, will enable the latter species to regain its hold on the town again and drive the wharf rat out, I do not know, but my hopes are for the roof rats' success and my expectations are against it.

RALEIGH, N. C.

VIABLE BERMUDA GRASS SEED PRODUCED IN THE LOCALITY OF RALEIGH, N. C.

By O. I. Tillman.

Cynodon Dactylon (L.) Pers. (*Capriola* Ktze.) Bermuda grass, also known as Wire grass, Bahama grass, Indian couch grass, Scotch grass, and Dog's-tooth grass, is of great economic value throughout the Southern states and is also a noxious pest in certain instances as the very qualities which make it valuable also render it objectionable. It is supposed that this grass will not develop germinable seed in the United States except in the arid Southwest, but it was found that in the vicinity of Raleigh, N. C., this grass produced such seed.

September 8, 1910, flowering stalks were gathered from a grass plot along the city streets. The glumes were stript from these and it was found that 76 per cent. were empty and that there were 24 per cent of pure seed which germinated 82 per cent. Another sample was collected October 11, 1910, along the roadside, a few miles from Raleigh, which was found to produce 4 per cent pure seed, which germinated 60 per cent. The seeds of both samples were kept until June of the following spring before being tested. The tests were made in a standard germinating chamber at an alternating temperature of 20-35 degrees C. The seeds were placed on top of moist blotting paper. The sprouts were strong and some were grown in the laboratory into good-sized plantlets.

Two samples of Bermuda grass seed from the trade, retailing at $1.25 per pound, were tested under the same conditions as the locally grown seed and germinated 27 per cent. and 17 per cent. respectively. This is a striking comparison of the superior germinating value of the locally produced seed and that of the trade, at least in this instance.

Since it has been found that Bermuda grass produces seed of so high a germination in a locality where it was not supposed to produce seed, it might be well if this fact were given consideration both in the cultivation and eradication of the grass.

State Department of Agriculture, Raleigh, N. C.